

Carbon Dioxide

Health Hazard Information Sheet

What is carbon dioxide?

Carbon dioxide (CO₂) is a colorless, odorless, non-flammable gas that naturally occurs in the atmosphere. CO₂ is produced by body metabolism and is a normal component of exhaled breath. It also results from the burning of fossil fuels and natural sources such as volcanic eruptions. CO₂ levels in outdoor air typically range from 300 to 400 ppm (0.03% to 0.04%) but can be as high as 600-900 ppm in metropolitan areas. Although it is most commonly present as a gas, CO₂ can also exist in a solid (dry ice) form.

How are FSIS employees exposed to carbon dioxide?

The most common exposure to CO₂ for FSIS employees results from the off-gassing of CO₂ gas from the use of dry ice for chilling and packing product. Dry ice is also sometimes blended with meat product. CO₂ levels directly next to an open bin of dry ice can be as high as 11,000 to 13,000 ppm. When dry ice is used in rooms without adequate ventilation CO₂ has been measured as high as 25,000 to 30,000 ppm. However, levels at poultry plant inspection stations range from about 900 to 3,500 ppm (depending on how close the inspection station is to the dry ice use). In a few cases elevated levels, in excess of 5,000 ppm have been found at inspection stations.

CO₂ gas is also used to euthanize both poultry and swine. This process is typically fully contained and CO₂ is vented to the atmosphere (outside the building). In some cases, compressed CO₂ gas is added to plant water (eg. chillers) to make carbonic acid for pH regulation. CO₂ is denser than air and can collect in high concentrations in open pits, lowlying areas and confined spaces where it can displace oxygen creating a serious health hazard.

What are the health effects of carbon dioxide?

CO₂ is considered to be minimally toxic by inhalation. The primary health effects caused by CO₂ are the result of its behavior as a simple asphyxiant. A simple asphyxiant is a gas which reduces or displaces the normal oxygen in breathing air.

Symptoms of mild CO₂ exposure may include headache and drowsiness. At higher levels, rapid breathing, confusion, increased cardiac output, elevated blood pressure and increased arrhythmias may occur.

Breathing oxygen depleted air caused by extreme CO₂ concentrations can lead to death by suffocation.

What are the symptoms of different levels of exposure?

5,000 ppm (0.5%)	OSHA Permissible Exposure Limit (PEL) and ACGIH Threshold Limit Value (TLV) for 8-hour exposure
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10,000 ppm (1.0%)	Typically no effects, possible drowsiness
15,000 ppm (1.5%)	Mild respiratory stimulation for some people
30,000 ppm (3.0%)	Moderate respiratory stimulation, increased heart rate and blood pressure, ACGIH TLV-Short Term
40,000 ppm (4.0%)	Immediately Dangerous to Life or Health (IDLH)
50,000 ppm (5.0%)	Strong respiratory stimulation, dizziness, confusion, headache, shortness of breath
80,000 ppm (8.0%)	Dimmed sight, sweating, tremor, unconsciousness, and possible death

The response to CO₂ inhalation varies greatly even in healthy individuals. The seriousness of the symptoms is dependent on the concentration of CO₂ and the length of time a person is exposed. Since CO₂ is odorless and does not cause irritation, it is considered to have poor warning properties. Fortunately, conditions from low to moderate exposures are generally reversible when a person is removed from a high CO₂ environment.

Another health hazard caused by CO₂ is frostbite by contact with solid CO₂ (dry ice) and vapors off-gassing from dry ice. Precautions should be taken to prevent direct skin and eye contact with dry ice or with vessels/bins containing dry ice. Similar effects may occur from compressed CO₂ gas as it is being released from a cylinder if it comes in contact with the skin or eyes. CO₂ gas at room temperature will not injure the skin or eyes.

What OSHA standards and exposure guidelines apply?

OSHA has established a Permissible Exposure Limit (PEL) for CO₂ of 5,000 parts per million (ppm) (0.5% CO₂ in air) averaged over an 8-hour work day (time-weighted average or TWA.) The American Conference of Governmental Industrial Hygienists (ACGIH) recommends an 8-hour TWA Threshold Limit Value (TLV) of 5,000 ppm and a Ceiling exposure limit (not to be exceeded) of 30,000 ppm for a 10-minute period. A value of 40,000 is considered immediately dangerous to life and health (IDLH value).

The TLVs are intended to minimize the potential for asphyxiation and undue metabolic stress. The ACGIH TLV supporting document states that: "Based on the long-term exposure studies, even though the majority of references are concerned with studies on physically fit males in confined spaces, a TLV-TWA of 5,000 ppm, is recommended. This value provides a good margin of safety from asphyxiation and from undue metabolic stress provided normal amounts of oxygen are present in the inhaled air." The TLV-STEL is based on short-term studies which showed that "concentrations of 27,600 to 39,500 ppm produced increased pulmonary ventilation rates. Therefore, a TLV-STEL of 30,000 ppm is considered appropriate."

How are occupational exposures monitored or measured?

CO₂ concentrations in air can be measured using detector tubes (for immediate short term samples) and passive indicator tubes or dosimeters (for longer TWA full or partial shift sampling). The primary OSHA method for the sampling and analysis of CO₂ involves using a

gas sampling bag followed by gas chromatography or infrared spectrophotometry analysis. If you would like to arrange for CO₂ monitoring at your workplace, please contact your district's Occupational Safety and Health Specialist.

What are the safety precautions protect for carbon dioxide?

Employees should receive training and be knowledgeable of the potential sources and symptoms of exposure to CO₂.

If you are working near any sources of dry ice and develop any of the symptoms of exposure, move to an area of fresh air immediately, and report the incident to your supervisor. (Fresh air or oxygen is the primary remedy for CO₂ exposure.

If you are pregnant consult with your supervisor and your physician about limiting exposure to CO₂.

If CO₂ is used to euthanize poultry or livestock ensure that you are aware of the location of the gas sources and emission vents, alarm signals and any special precautions for working in those areas.

Do not enter areas where CO₂ levels exceed 20,000 ppm until ventilation has been provided to bring the concentration down to safe levels.

Do not stand directly next to open bins that contain dry ice or in vapors from these bins. Do not touch dry ice or a bin containing dry ice.

How should training for this Health Hazard Information Sheet be recorded?

Per requirements found in FSIS Directive 4791.1 Section IX, all occupational health and safety training is to be recorded using either AgLearn or FSIS form 3530-12. Training records are to include the topics covered, date, and employee name. The Agency is to retain all training records for a minimum of five years."

Resources

For more information, see the OSHA website:

https://www.osha.gov/dts/chemicalsampling/data/CH_225400.html

About the ESHG

The FSIS Environmental Safety and Health Group (ESHG) is devoted to providing a safe and healthful work environment for FSIS employees. More information on safety topics can be found on the intranet site <http://www.tinyurl.com/FSIS-ESHG> or by email askemployeesafety@fsis.usda.gov